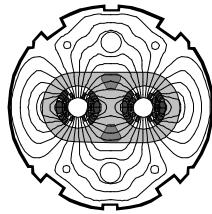


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the  
**Large  
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Collider**  
project

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**313365**

Date: 2001-10-24

## Interface Specification

# INNER TRIPLET FEEDBOXES: DFBX – POWER CONVERTERS

### ***Abstract***

This specification establishes the detailed interface requirements between the DFBX and the DC Connections for Main and Corrector Magnet Current.

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***History of Changes***

<b>Rev. No.</b>	<b>Date</b>	<b>Pages</b>	<b>Description of Changes</b>
1.0	2001-05-05		Initial submission.
1.1	2001-08-24	5	Added text indicating that designations for current lead positions will be marked on top of mounting flanges.
		6-7	Updated figures 5-1a,b and 5-2a,b.
		12	Updated figures 6.1.2-2,3.
		14	Updated figures 6.1.3-2,3.
		16-17	Corrected and updated Tables 7-2,3.
		18	Updated drawing and reference lists.
1.1	2001-10-23	all	Released version

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## 1. INTRODUCTION

This specification establishes the detailed DC power interface requirements between the DFBX boxes and the main and corrector magnets. This specification applies to all DFBX which are located at IR1 (left and right), IR2 (left and right), IR5 (left and right), and IR8 (left and right).

## 2. DFBX EQUIPMENT CODES

Because each of the eight DFBX has a unique design, the following equipment codes have been adopted facilitating a direct application of the LHC documentation system. In Table 2-1, "IRnR" signifies the right side of the Interaction Point n, and "IRnL" signifies the left side of Interaction Point n.

**Table 2-1. Individual DFBX Equipment Codes.**

Location	IR1 L	IR1 R	IR2 L	IR2 R	IR5 L	IR5 R	IR8 L	IR8 R
Code	DFBXA	DFBXB	DFBXC	DFBXD	DFBXE	DFBXF	DFBXG	DFBXH

## 3. CO-ORDINATE SYSTEM

The local coordinate systems used in this specification with respect to the DFBX are given in the DFBX General Interfaces Specification [1] and shown in the figures below. The local coordinate system is defined by the following:

- X=0, Z=0 at center of beam line.
- Y=0 at front face of flange.
- Positive X is toward the machine center.
- Positive Y is in clockwise beam direction.
- Positive Z is vertical up from LHC plane.

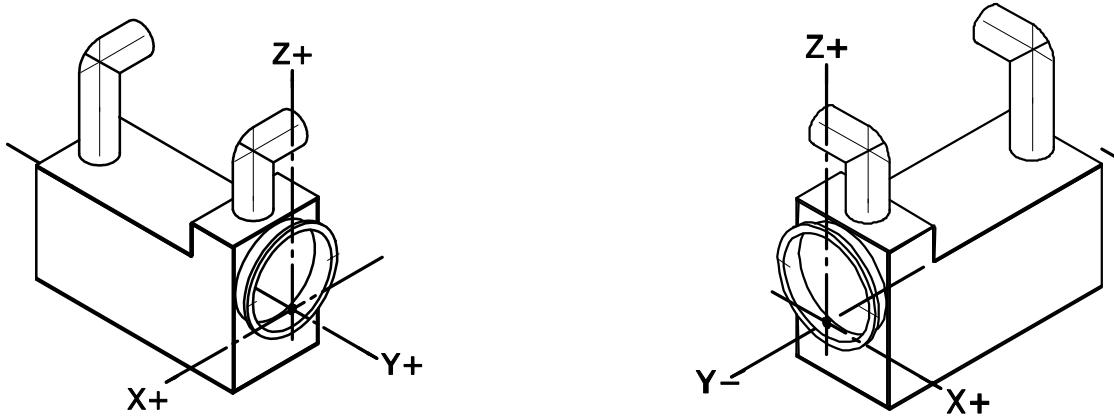


Figure 3-1. DFBX co-ordinate system – left and right sides of IR.

The origins of the DFBX local coordinate systems with respect to the CERN global coordinates are listed in Table 3-1. In deriving these locations we use the referenced CERN drawing and set the flange to flange separation between the DFBX and the LQX to be 510 mm [2].

**Table 3-1. Position of DFBX Local Coordinate Systems**

<b>Code</b>	<b>Distance (mm) from IP</b>	<b>CERN Dwg. No.</b>	<b>Dwg. Ref. List</b>
DFBXA	55052 Left of IP1	LHCLSX_0001D	[a]
DFBXB	55052 Right of IP1	LHCLSX_0002D	[b]
DFBXC	55052 Left of IP2	LHCLSX_0003D	[c]
DFBXD	55052 Right of IP2	LHCLSX_0004D	[d]
DFBXE	55052 Left of IP5	LHCLSX_0009D	[e]
DFBXF	55052 Right of IP5	LHCLSX_0010D	[f]
DFBXG	55052 Left of IP8	LHCLSX_0015D	[g]
DFBXH	55052 Right of IP8	LHCLSX_0016D	[h]

## 4. DFBX CURRENT LEAD CONFIGURATION

The following table lists the types, quantities and designations of the current leads for each of the eight DFBX. The designation for each current lead position will be permanently marked on the mounting flanges so that the lead configuration is discernible when viewing the top of the DFBX vacuum vessel.

**Table 4-1. Current lead configuration.**

Type	Designation	DFBXA	DFBXB	DFBXC	DFBXD	DFBXE	DFBXF	DFBXG	DFBXH
HTS	DFLX	4	4	6	6	4	4	6	6
600 A	DFLY	14	14	14	14	14	14	14	14
120 A	DFLZ	10	10	10	10	10	10	10	10

## 5. GENERAL LAYOUT

Figure 5-1a shows a plan view sketch of the DFBX on the left side of IP's 2 and 8. The right side box top is shown in Figure 5-1b. Corresponding views for the left and right sides of IP's 1 and 5 are shown in Figures 5-2a and 5-2b, respectively. Table 4-1 shows the number and type of current leads for each of the DFBX boxes.

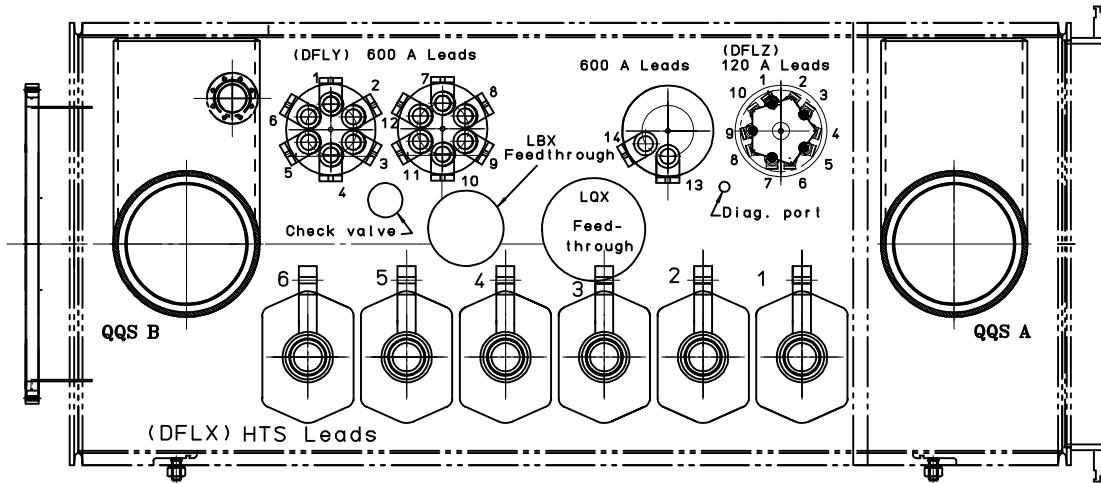


Figure 5-1a. Plan view schematic of current lead arrangement and designations in DFBX for IP 2 and 8 (left). (Note: 10 degree inclination angle of leads is not shown here.)

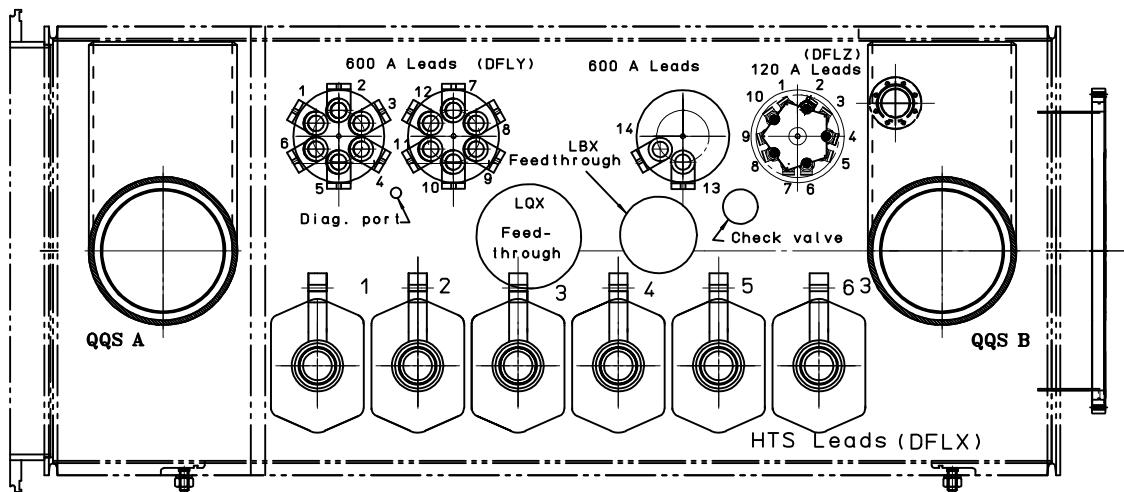


Figure 5-1b. Plan view schematic of current lead arrangement and designations in DFBX for IR 2 and 8 (right). (Note: 10 degree inclination angle of leads is not shown here.)

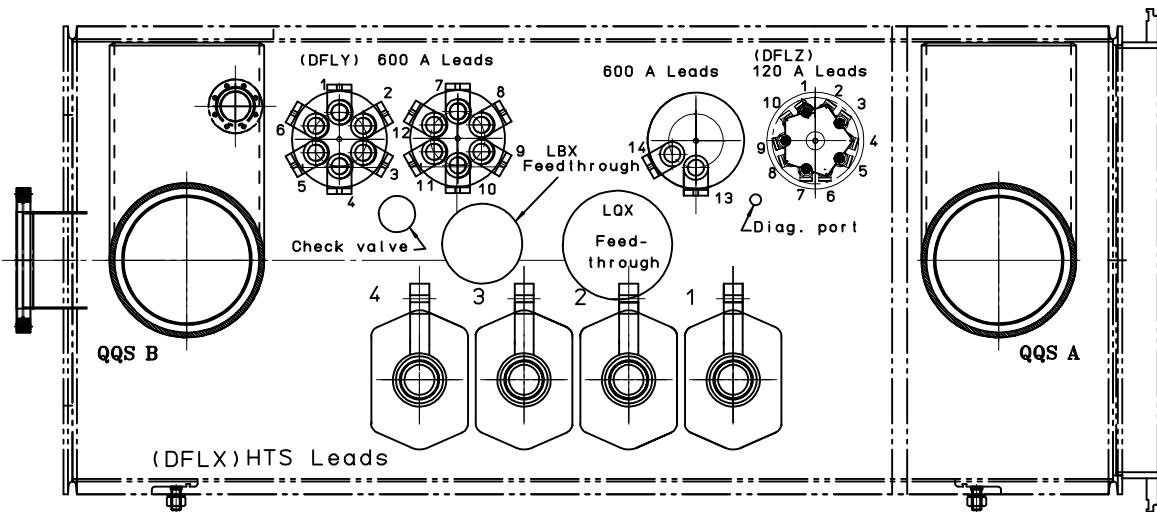


Figure 5-2a. Plan view schematic of current lead arrangement and designations in DFBX for IR 1 and 5 (left). (Note: 10 degree inclination angle of leads is not shown here.)

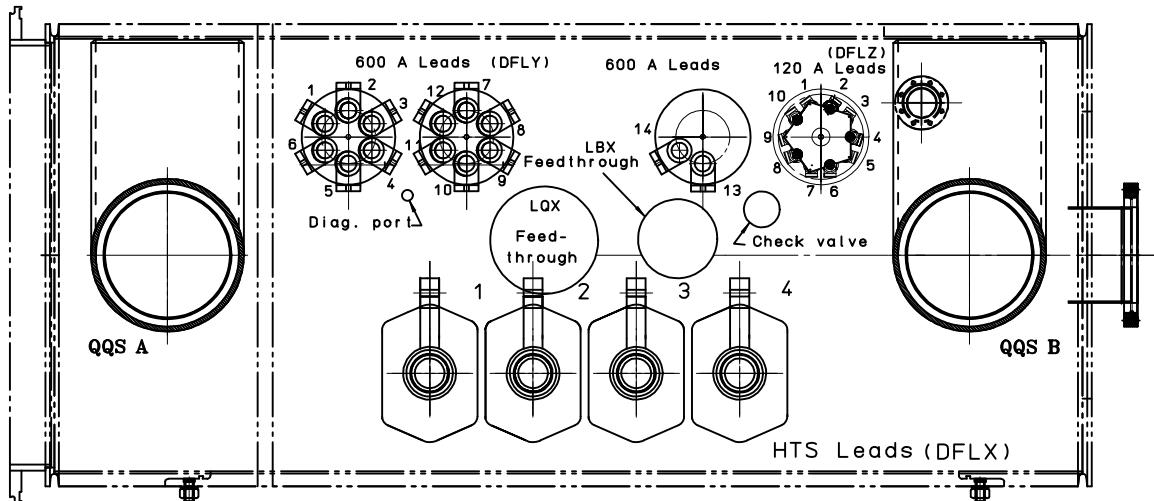


Figure 5-2b. Plan view schematic of current lead arrangement and designations in DFBX for IP 1 and 5 (right). (Note: 10 degree inclination angle of leads is not shown here.)

## **6. MECHANICAL INTERFACE**

## 6.1 MECHANICAL CONNECTION DETAILS

### 6.1.1 HTS LEAD CONNECTION

Figure 6.1.1-1 shows the HTS lead end in the installed position along with the Z co-ordinate of the center of the warm terminal, relative to the DFBX co-ordinate system. The CERN DC power cable lug will be bolted to the warm terminal at the top end of the HTS lead. (See figures 6.1.1-2 and 6.1.1-3.) The arrangement of the HTS leads and the X and Y co-ordinates of the warm terminal center with respect to the DFBX coordinate system for IP 2 and 8 left are shown in Figure 6.1.1-2. Figures 6.1.1-3 through 6.1.1-5 show the corresponding information for IP 2 and 8 right, IP 1 and 5 left, and IP 1 and 5 right, respectively.

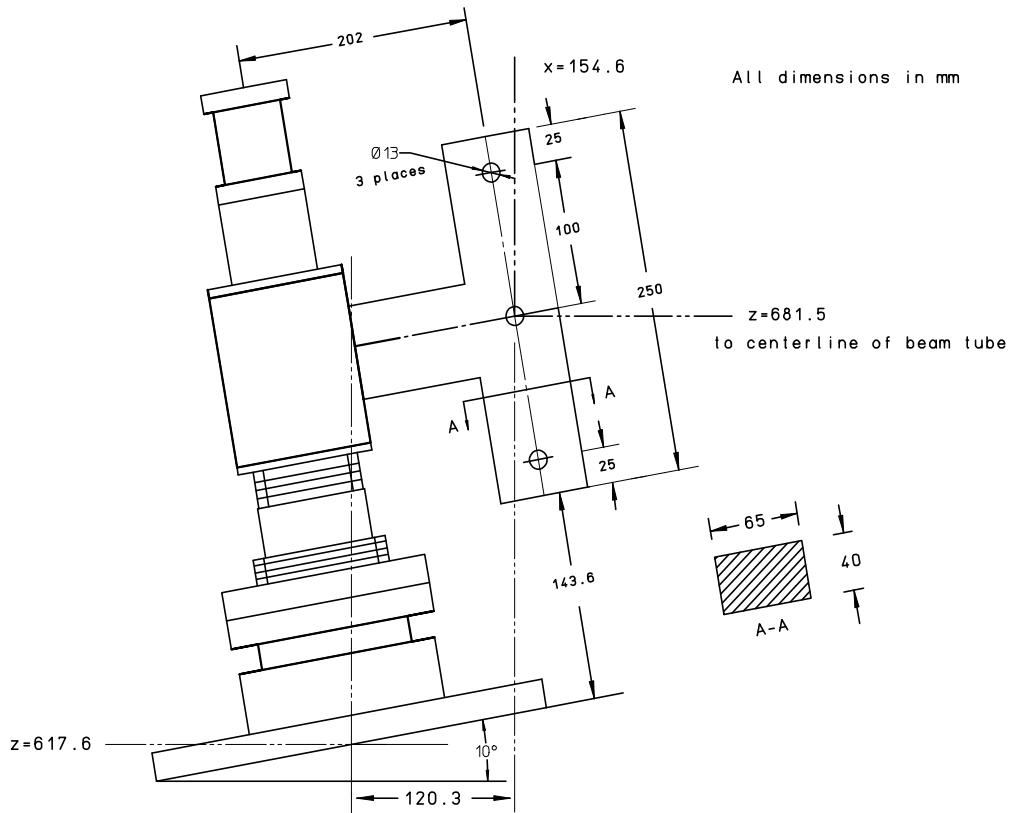


Figure 6.1.1-1. Detailed sketch of the HTS current lead end.

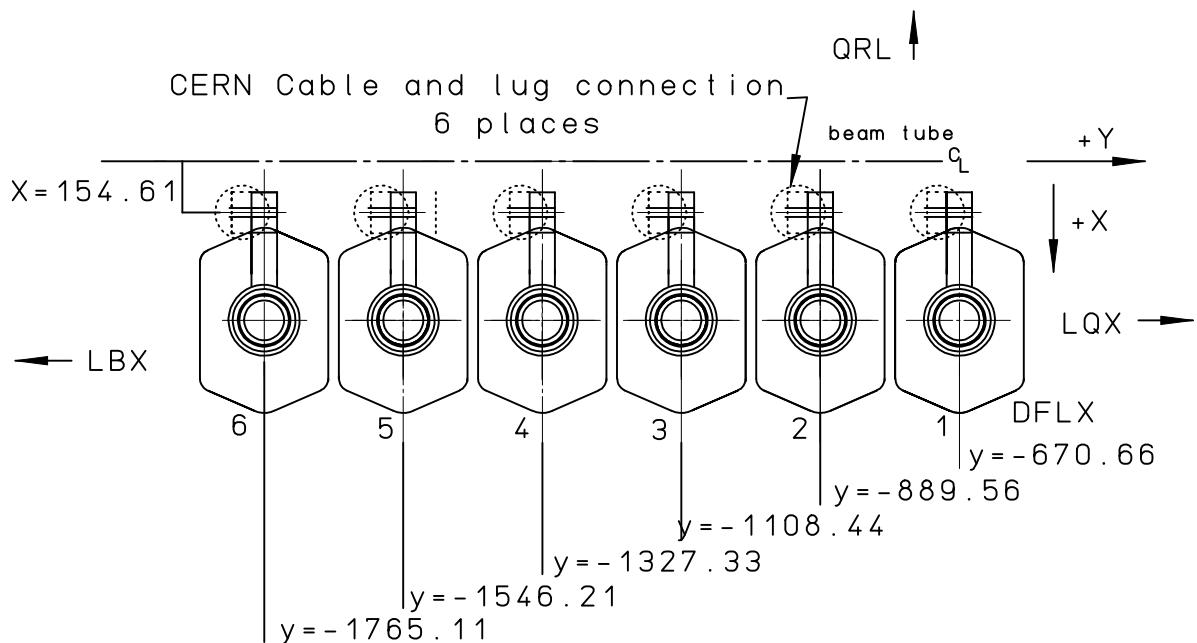


Figure 6.1.1-2. Co-ordinates of HTS lead warm terminal centers for IP2 and 8 left.

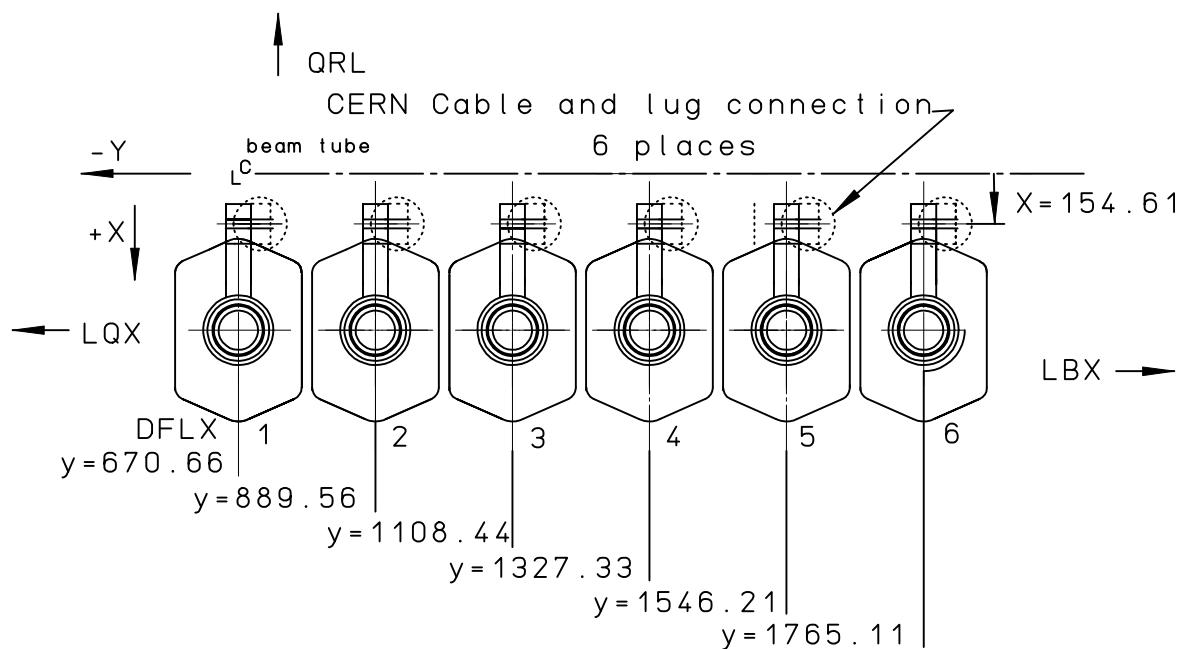


Figure 6.1.1-3. Co-ordinates of HTS lead warm terminal centers for IP2 and 8 right.

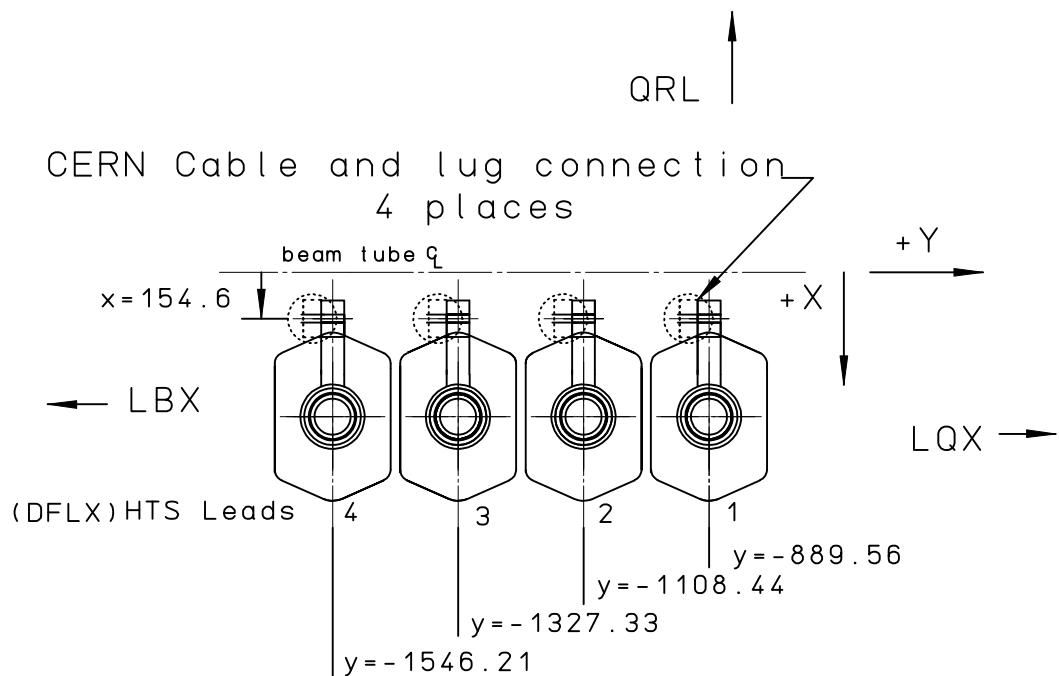


Figure 6.1.1-4. Co-ordinates of HTS lead warm terminal centers for IP1 and 5 left.

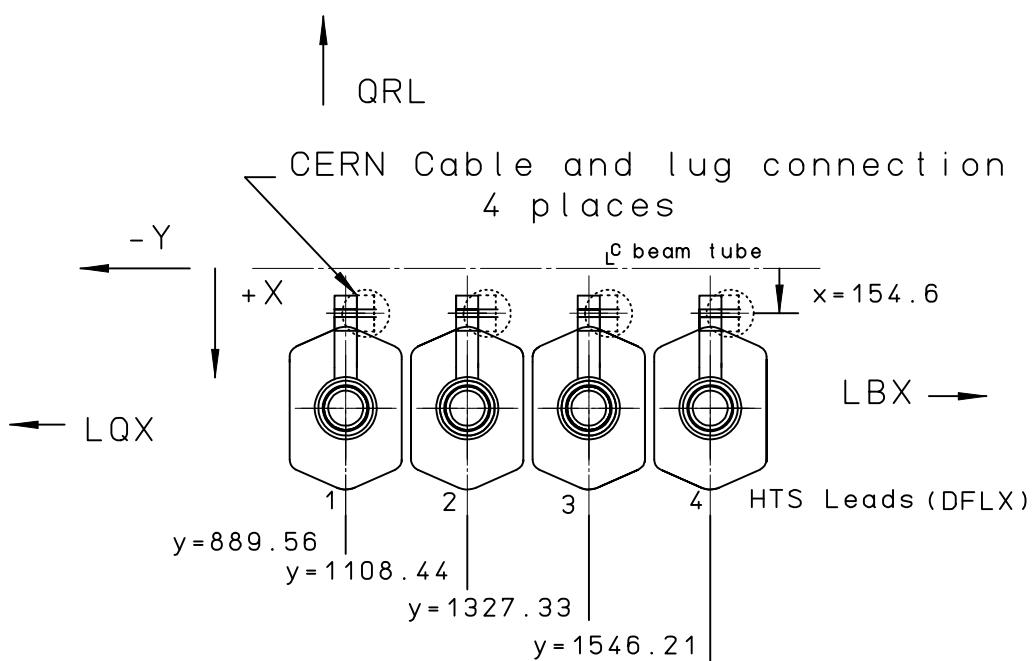


Figure 6.1.1-5. Co-ordinates of HTS lead warm terminal centers for IP1 and 5 right.

### 6.1.2 600 A VAPOR-COOLED LEAD CONNECTION

The power cable lugs and current lead ends for the 600 A current leads are shown in Figure 6.1.2-1. The y-locations of the 600 A leads are shown in Figures 6.1.2-2 and 6.1.2-3. The gas outlet and instrumentation ports are specified in [3] and [4] respectively.

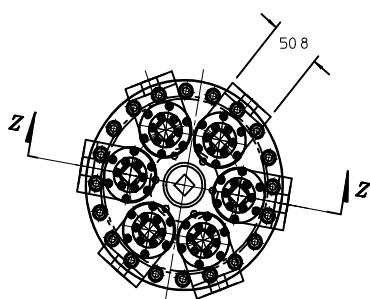
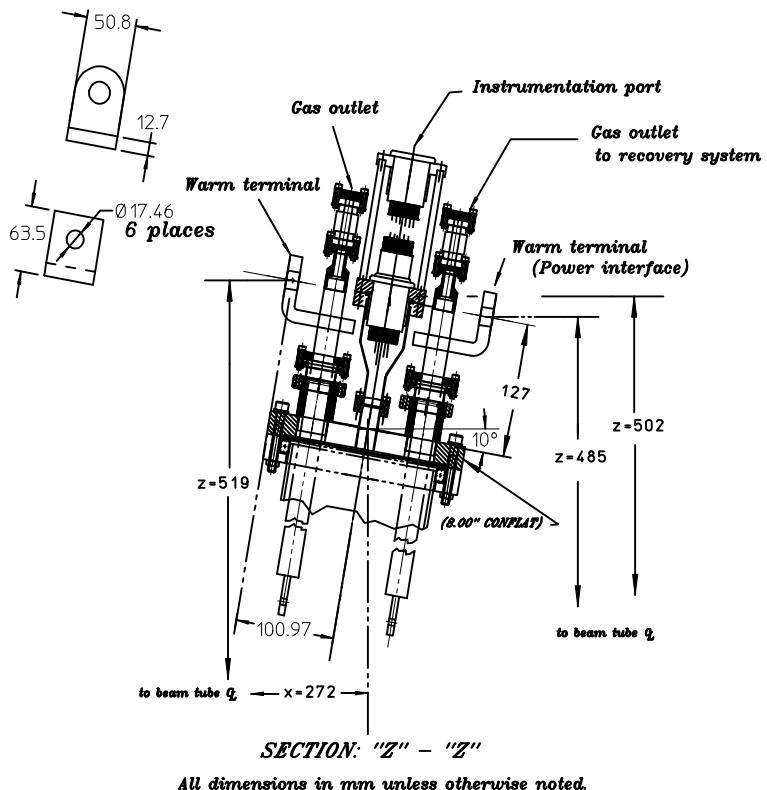


Figure 6.1.2-1. Detailed sketch of the 600 A current lead assembly end.

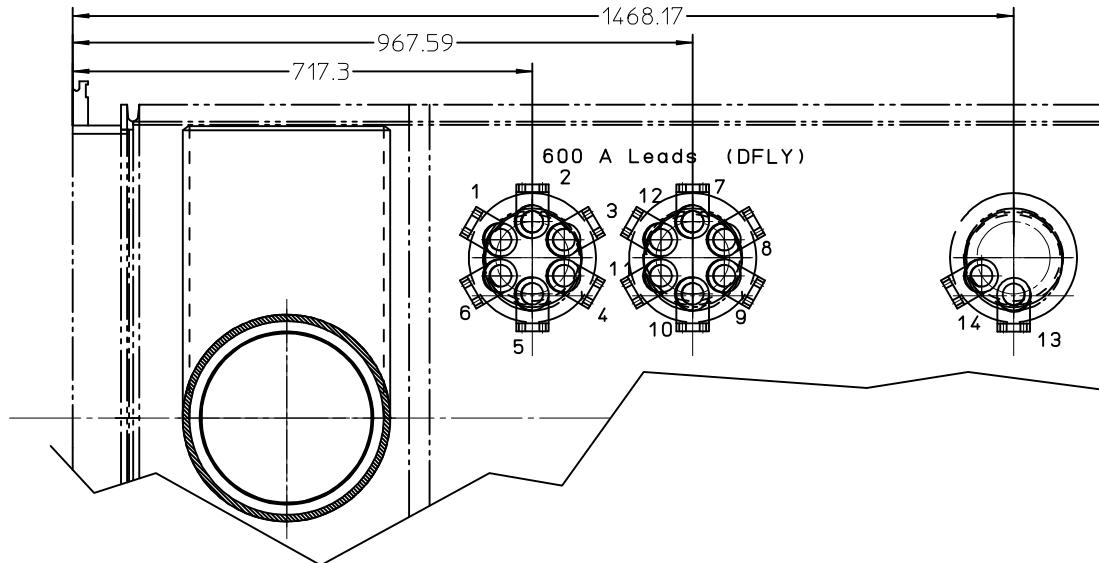


Figure 6.1.2-2. Y-locations of the 600 A current lead assemblies (right side of IP).

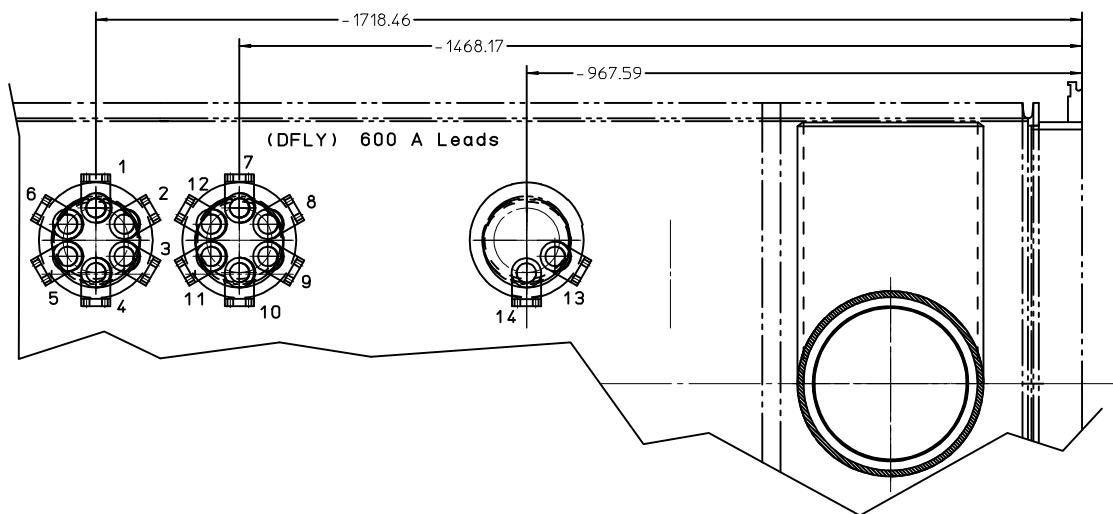
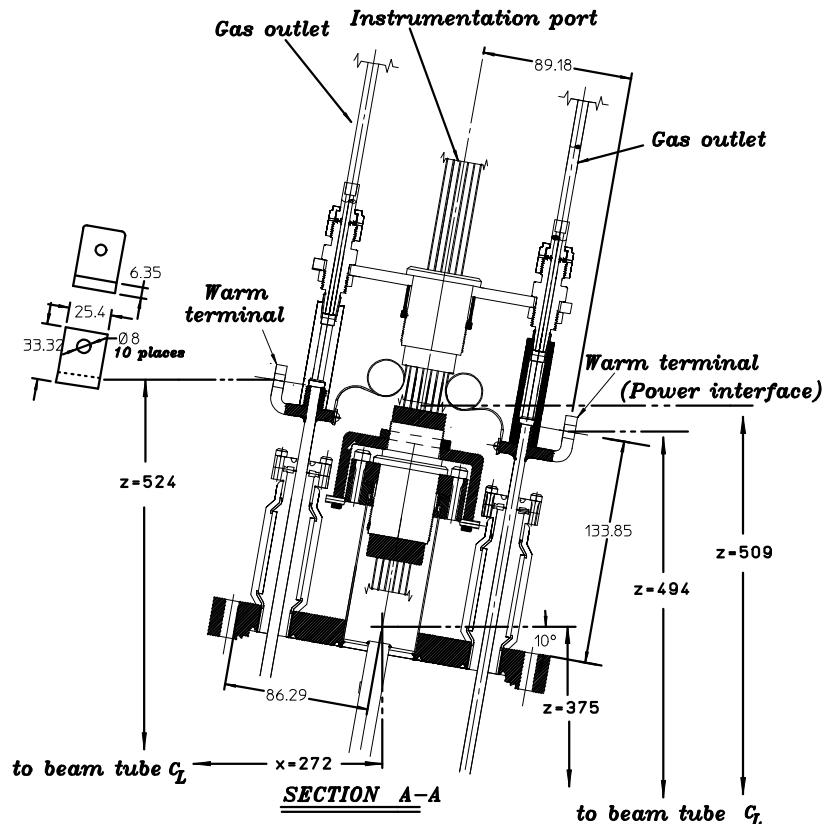


Figure 6.1.2-3. Y-locations of the 600 A current lead assemblies (left side of IP).

### 6.1.3 120 A VAPOR-COOLED LEAD CONNECTION

The power cable lugs and current lead ends for the 120 A current leads are shown in Figure 6.1.3-1. The Y-locations of the 120 A leads are shown in Figures 6.1.3-2 and 6.1.3-3. The gas outlet and instrumentation ports are specified in [3] and [4] respectively.



All dimensions in mm unless otherwise noted.

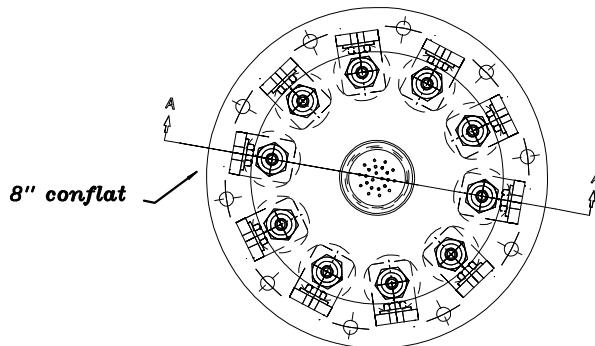


Figure 6.1.3-1. Detailed sketch of the 120 A current lead assembly end.

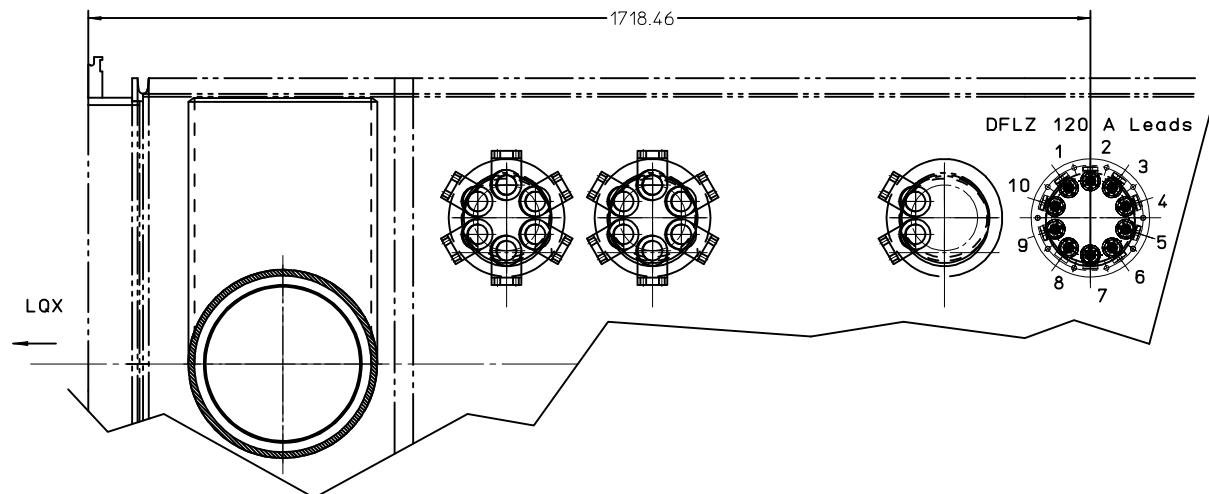


Figure 6.1.3-2. Y-locations of the 120 A current lead assemblies (right side of IP).

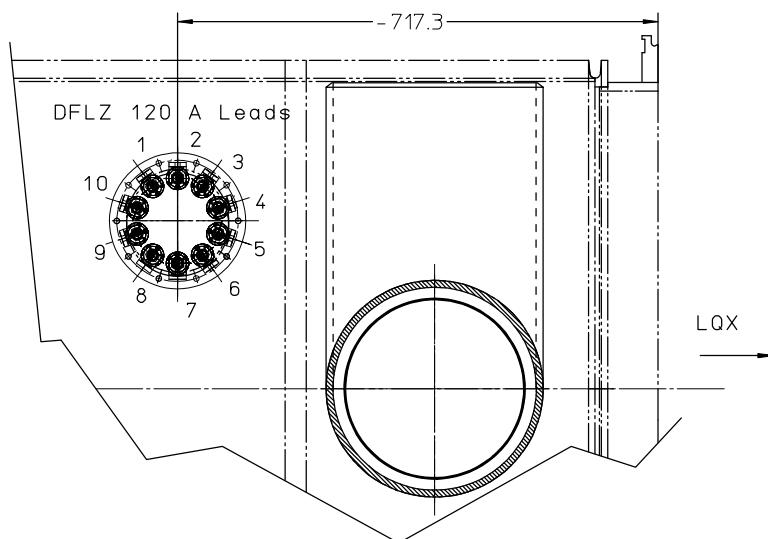


Figure 6.1.3-3. Y-locations of the 120 A current lead assemblies (left side of IP).

## 6.2 LOADING

To prevent over-stressing of the current leads by loads induced by the power supply cable at the connection, the supply cable should be supported near the current lead connection. The maximum allowable load for the HTS lead is 500 N. The 600 A lead maximum allowable is 200 N. The allowable load for the 120 A lead is 40 N.

**Table 6.2-1 Maximum allowable loads on current leads.**

LEAD	HTS	600 A	120 A
LOAD (N)	500	200	40

## 7. CURRENT LEAD IDENTIFICATION

The magnet power schematics for the DFBX current leads are listed in Table 7-1. In Tables 7-2 and 7-3, the designations on the schematic are correlated with the appropriate DFBX current lead.

**Table 7-1. Table of main magnet power schematics.**

Location	DFBX Box ID	CERN Drawing No.	Reference
IP 1	DFBX A, B	LHCLSD1_0003	[i]
IP 2	DFBX C, D	LHCLSD2_0003	[j]
IP 5	DFBX E, F	LHCLSD5_0003	[k]
IP 8	DFBX G, H	LHCLSD8_0003	[l]

**Table 7-2. Magnet power schematic and DFBX current lead designations for IP 1, 2, 5 and 8 left.**

<b>Lead ID</b>	<b>Type *</b>	<b>DFBXA</b>	<b>DFBXC</b>	<b>DFBXE</b>	<b>DFBX G</b>
DFLX1	■	RTQX2.L1	RTQX2.L2	RTQX2.L5	RTQX2.L8
DFLX2	○	RTQX2.L1	RTQX2.L2	RTQX2.L5	RTQX2.L8
DFLX3	○	RQX.L1	RQX.L2	RQX.L5	RQX.L8
DFLX4	■	RQX.L1	RQX.L2	RQX.L5	RQX.L8
DFLX5	○	None	RD1.L2	None	RD1.L8
DFLX6	■	None	RD1.L2	None	RD1.L8
DFLY1	○	RCBXV1.L1	RCBXV1.L2	RCBXV1.L5	RCBXV1.L8
DFLY2	■	RCBXV1.L1	RCBXV1.L2	RCBXV1.L5	RCBXV1.L8
DFLY3	■	RCBXV2.L1	RCBXV2.L2	RCBXV2.L5	RCBXV2.L8
DFLY4	○	RCBXV2.L1	RCBXV2.L2	RCBXV2.L5	RCBXV2.L8
DFLY5	■	RCBXH1.L1	RCBXH1.L2	RCBXH1.L5	RCBXH1.L8
DFLY6	○	RCBXH1.L1	RCBXH1.L2	RCBXH1.L5	RCBXH1.L8
DFLY7	○	RCBXH3.L1	RCBXH3.L2	RCBXH3.L5	RCBXH3.L8
DFLY8	■	RCBXH3.L1	RCBXH3.L2	RCBXH3.L5	RCBXH3.L8
DFLY9	■	RCBXV3.L1	RCBXV3.L2	RCBXV3.L5	RCBXV3.L8
DFLY10	○	RCBXV3.L1	RCBXV3.L2	RCBXV3.L5	RCBXV3.L8
DFLY11	■	RCBXH2.L1	RCBXH2.L2	RCBXH2.L5	RCBXH2.L8
DFLY12	○	RCBXH2.L1	RCBXH2.L2	RCBXH2.L5	RCBXH2.L8
DFLY13	■	RQSX3.L1	RQSX3.L2	RQSX3.L5	RQSX3.L8
DFLY14	○	RQSX3.L1	RQSX3.L2	RQSX3.L5	RQSX3.L8
DFLZ1	○	RCOX3.L1	RCOX3.L2	RCOX3.L5	RCOX3.L8
DFLZ2	■	RCOX3.L1	RCOX3.L2	RCOX3.L5	RCOX3.L8
DFLZ3	■	RCOSX3.L1	RCOSX3.L2	RCOSX3.L5	RCOSX3.L8
DFLZ4	○	RCOSX3.L1	RCOSX3.L2	RCOSX3.L5	RCOSX3.L8
DFLZ5	■	RCSSX3.L1	RCSSX3.L2	RCSSX3.L5	RCSSX3.L8
DFLZ6	○	RCSSX3.L1	RCSSX3.L2	RCSSX3.L5	RCSSX3.L8
DFLZ7	■	RCTX3.L1	RCTX3.L2	RCTX3.L5	RCTX3.L8
DFLZ8	○	RCTX3.L1	RCTX3.L2	RCTX3.L5	RCTX3.L8
DFLZ9	■	RCSX3.L1	RCSX3.L2	RCSX3.L5	RCSX3.L8
DFLZ10	○	RCSX3.L1	RCSX3.L2	RCSX3.L5	RCSX3.L8

\* ■ designates A terminal; ○ designates B terminal.

**Table 7-3. Magnet power schematic and DFBX current lead designations for IP 1, 2, 5 and 8 right.**

<b>Lead ID</b>	<b>Type *</b>	<b>DFBXB</b>	<b>DFBXD</b>	<b>DFBXF</b>	<b>DFBXH</b>
DFLX1	■	RQX.R1	RQX.R2	RQX.R5	RQX.R8
DFLX2	○	RQX.R1	RQX.R2	RQX.R5	RQX.R8
DFLX3	○	RTQX2.R1	RTQX2.R2	RTQX2.R5	RTQX2.R8
DFLX4	■	RTQX2.R1	RTQX2.R2	RTQX2.R5	RTQX2.R8
DFLX5	○	None	RD1.R2	None	RD1.R8
DFLX6	■	None	RD1.R2	None	RD1.R8
DFLY1	○	RCBXH3.R1	RCBXH3.R2	RCBXH3.R5	RCBXH3.R8
DFLY2	■	RCBXH3.R1	RCBXH3.R2	RCBXH3.R5	RCBXH3.R8
DFLY3	○	RCBXH2.R1	RCBXH2.R2	RCBXH2.R5	RCBXH2.R8
DFLY4	■	RCBXH2.R1	RCBXH2.R2	RCBXH2.R5	RCBXH2.R8
DFLY5	■	RCBXV3.R1	RCBXV3.R2	RCBXV3.R5	RCBXV3.R8
DFLY6	○	RCBXV3.R1	RCBXV3.R2	RCBXV3.R5	RCBXV3.R8
DFLY7	○	RCBXH1.R1	RCBXH1.R2	RCBXH1.R5	RCBXH1.R8
DFLY8	■	RCBXH1.R1	RCBXH1.R2	RCBXH1.R5	RCBXH1.R8
DFLY9	■	RCBXV1.R1	RCBXV1.R2	RCBXV1.R5	RCBXV1.R8
DFLY10	○	RCBXV1.R1	RCBXV1.R2	RCBXV1.R5	RCBXV1.R8
DFLY11	■	RCBXV2.R1	RCBXV2.R2	RCBXV2.R5	RCBXV2.R8
DFLY12	○	RCBXV2.R1	RCBXV2.R	RCBXV2.R5	RCBXV2.R8
DFLY13	■	RQSX3.R1	RQSX3.R2	RQSX3.R1	RQSX3.R8
DFLY14	○	RQSX3.R1	RQSX3.R2	RQSX3.R1	RQSX3.R8
DFLZ1	○	RCOX3.R1	RCOX3.R2	RCOX3.R5	RCOX3.R8
DFLZ2	■	RCOX3.R1	RCOX3.R2	RCOX3.R5	RCOX3.R8
DFLZ3	○	RCSSX3.R1	RCSSX3.R2	RCSSX3.R5	RCSSX3.R8
DFLZ4	■	RCSSX3.R1	RCSSX3.R2	RCSSX3.R5	RCSSX3.R8
DFLZ5	■	RCSX3.R1	RCSX3.R2	RCSX3.R5	RCSX3.R8
DFLZ6	○	RCSX3.R1	RCSX3.R2	RCSX3.R5	RCSX3.R8
DFLZ7	■	RCTX3.R1	RCTX3.R2	RCTX3.R5	RCTX3.R8
DFLZ8	○	RCTX3.R1	RCTX3.R2	RCTX3.R5	RCTX3.R8
DFLZ9	■	RCOSX3.R1	RCOSX3.R2	RCOSX3.R5	RCOSX3.R8
DFLZ10	○	RCOSX3.R1	RCOSX3.R2	RCOSX3.R5	RCOSX3.R8

\* ■ designates A terminal; ○ designates B terminal.

## **8. DRAWINGS**

- a. LHCLSX\_0001D, LHC Layout Drawings of Long Straight Sections.
- b. LHCLSX\_0002D, LHC Layout Drawings of Long Straight Sections.
- c. LHCLSX\_0003D, LHC Layout Drawings of Long Straight Sections.
- d. LHCLSX\_0004D, LHC Layout Drawings of Long Straight Sections.
- e. LHCLSX\_0009D, LHC Layout Drawings of Long Straight Sections.
- f. LHCLSX\_0010D, LHC Layout Drawings of Long Straight Sections.
- g. LHCLSX\_0015D, LHC Layout Drawings of Long Straight Sections.
- h. LHCLSX\_0016D, LHC Layout Drawings of Long Straight Sections.
- i. LHCLSD1\_0003, "Electrical Diagram of LHC Magnets IP 1 – C4L1 to C4R1".
- j. LHCLSD2\_0003, "Electrical Diagram of LHC Magnets IP2 – C5L2 to C5R2".
- k. LHCLSD5\_0003, "Electrical Diagram of LHC Magnets IP5 – C4L5 to C4R5".
- l. LHCLSD8\_0003, "Electrical Diagram of LHC Magnets IP8 – C5L8 to C5R8".

## **9. REFERENCES**

- LHC Engineering Specification, "Inner Triplet Feedboxes General Interfaces", LHC-DFBX\_-ES-0200.00 rev 1.0.
- LHC Engineering Specification, "Interface Specification: Inner Triplet Feedboxes DFBX to LQX", LHC-DFBX-ES-210 rev1.1.
- LHC Engineering Specification, "Interface Specification: DFBX to Helium Gas Recovery," LHC-DFBX-ES-280.
- LHC Engineering Specification, "Interface Specification: Inner Triplet Feedboxes: Electrical Signals," LHC-DFBX-ES-270.